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COMPLIANCE OF SELECTED WATER QUALITY PARAMETERS TO THE OBJECTIVES OF THE INTERNATIONAL WATERS OF THE SAINT JOHN RIVER BASIN DURING THE YEARS 1982 AND 1983

IWD-AR-WQB-84-56

INLAND WATERS DIRECTORATE
ATLANTIC REGION
WATER QUALITY BRANCH
MONCTON, NEW BRUNSWICK

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ENVIRONMENT CANADA

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Water Quality Branch

Atlantic Region

Moncton, New Brunswick

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A copy will be made available in French upon request.

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LETTER OF TRANSMITTAL

Water Quality Branch
Inland Waters Directorate
Environment Canada
P. O. Box 861
Moncton, New Brunswick

Dr. P. E. Belliveau, Chairman
International Technical Advisory Sub-committee
on Water Quality in the Saint John River

Dear Dr. Belliveau:

The Water Quality Branch is pleased to transmit to you a report on the compliance of selected water quality parameters to the Objectives for the International waters of the Saint John River during the years 1982/1983.

Yours truly,

D. H. Cullen, Chief
Water Quality Branch

ABSTRACT

This report compares the 1982/1983 water quality data for the Saint John River with the Water Quality Objectives for selected parameters. Values of grab samples for pH, dissolved oxygen, dissolved aluminum, suspended solids, water temperature and zinc complied with both "safe" and "acute" Objectives. Average extractable aluminum and total phosphorus concentrations frequently exceeded the "safe" Objectives. However this appeared to be the result of periods of high sediment loading and thus does not represent potential toxicity or eutrophication effects. Three transboundary streams did not comply with both "safe" and "acute" total phosphorus Objectives suggesting that eutrophication in these basins is a real concern.

RÉSUMÉ

Dans ce rapport, les données recueillies en 1982/83 sur la qualité des eaux du fleuve Saint-Jean sont comparées aux objectifs de la qualité des eaux recommandés pour certains paramètres. Les valeurs de pH, oxygène dissout, aluminium dissout, matières en suspension, température de l'eau et zinc se conformaient aux objectifs "sans danger" et "aigus". Les valeurs moyennes de concentrations d'aluminium extractible et de phosphore total excédaient fréquemment les objectifs "sans danger". Cependant ceci semblait être relié à des périodes de chargement élevé de sédiments et ne représentait donc aucun danger potentiel de toxicité ou d'eutrophisation. Pour le phosphore total, trois rivières transfrontalières ne se conformaient pas aux objectifs "sans danger" et "aigus". Ceci suggère que l'eutrophisation dans ces trois bassins est une réelle inquiétude.

INTRODUCTION

The 120 km reach of the Saint John River from the Saint Francis River to Grand Falls forms the international boundary between Canada and the United States. In February, 1975, use specific Water Quality Objectives for the international waters of the Saint John River were recommended for 61 parameters and a number of pesticides. Since then, these Objectives have been revised and the recommended changes have been presented in the report of the International Technical Advisory Subcommittee on Water Quality in the Saint John River (ITAS, 1980). These have now been accepted by both governments as goals to reach for.

These Objectives have been based on the fishable - swimmable criteria incorporated into United States legislation and agreed to by the Canada-US Committee in 1975. Thus they are a combination of Water Quality Objectives developed separately for fisheries and contact recreation uses. In general, if the water quality is degraded to a level slightly worse than the recommended Objective, a threat to one or more of the intended uses could be expected.

With each Objective, two separate levels of quality were developed to support the fisheries or aquatic biota aspect. There is a single Objective for the "safe level" which represents the long-term management goal and should be compared to annual or seasonal averages of monitoring data. In addition, there is an alert or "acute" level which identifies immediate problems within single grab samples.

The Water Quality Branch presently monitors the Saint John River and its tributaries on a regular basis to provide data to compare with the established Water Quality Objectives. Samples are collected from eleven water quality stations located on the international portion of the Saint John River and major tributaries. These stations are listed in Table 1. This program has been designed for comparison of annual mean and grab sample values with established Objectives and thus no interpretation of the water quality data will be attempted. The following section presents the results of the 1982/83 Saint John River water quality program and compares the data with Objectives for selected parameters. The list of these parameters and their NAQUADAT codes (WQB, 1984) are presented in Table 2.

TABLE 1: A List of Sampling Stations with their NAQUADAT Numbers and descriptions

Site	NAQUADAT #	Location
1	00NB01AD0013	Saint Francis River @ Picnic Site
2	00NB01AD0001	Saint John River @ Clair
3	00NB01AD0016	Madawaska River below Fraser Outfall
4	00NB01AF0021	Green River at WSC gauge
5	00NB01AF0023	Grand River at TCH bridge
6	00NB01AF0002	Saint John River @ St. Leonard off Int. Bridge
7	01NB01AF0005	Saint John River above dam @ Grand Falls
8	00NB01AG0003	Limestone Stream at Four Falls
9	01NB01AG0001	Aroostook River above Tinker Dam
10	00NB01AJ0012	Big Presquile Str. at Can/US Border
11	00NB01AJ0029	Meduxnekeag River at Belleville

TABLE 2: Parameters measured and their NAQUADAT Parameter Codes

Parameter	NAQUADAT Code
Water Temperature - Field ^{o}C	02061S
Dissolved Oxygen - Field mg/L	08102F
pH - Field	10301F
Aluminum - Extractable mg/L	13305P
Aluminum - Dissolved mg/L	13106L
Suspended Solids mg/L	10401L
Phosphate - Total Dissolved mg/L	15104L
Zinc - Extractable mg/L	30304P

RESULTS AND DISCUSSION

Prior to comparing water quality data to the Objectives, it is necessary to first consider some possible difficulties. Small sample size is a common problem in many routine monitoring programs, and thus normality of data cannot be assumed. In fact as water quality data are generally not normally distributed, the use of parametric statistics such as the mean is often statistically unsound. In an attempt to overcome this difficulty, the ITAS report of 1980 used geometric mean values for comparison with water quality Objectives. Although this geometric mean is preferable to the arithmetic mean, it is felt that the use of the non-parametric median value would be more suitable for the extremely small data sets of the WQB monitoring program. The non-compliance tables which are presented in the following section compare the arithmetic mean values to the "safe" Objective and should thus be viewed with extreme caution. In cases of non-compliance, it is necessary to check the median value in order to corroborate the applicability of the arithmetic mean.

In addition to the statistical considerations, it is necessary to also address whether the calculated mean or median values actually represent "average" river conditions. Many water quality parameters undergo wide seasonal fluctuations, being dependent on variations in the hydrologic cycle. Therefore it is quite likely that mean or median values calculated from a small number of observations may be biased either high or low depending on the discharge conditions at the time of

sampling. Thus even though the median value is preferred over the mean, it also must be used with caution when calculated from a small number of observations. This consideration of the importance of river discharge brings to light a possible problem with the use of the "acute" Objectives and individual observations. With the small sample size, it is possible that a majority of the observations are made during periods of average flow conditions and thus 100% compliance would be expected. If, however, a large percentage of the observations were made during extremes in the hydrograph then there may be a high percentage of non-compliance. Therefore, although the individual observations may be compared to the "acute" Objectives, they cannot be used to estimate the overall percentage of compliance or non-compliance.

There are three possible solutions which would help to overcome the short-comings of future Water Quality Objective monitoring programs. The first is to increase the sampling frequency in order to provide a more sound statistical data base. However, this is time-consuming and relatively expensive on both the field and analytical side. The second alternative is to time the sampling such that observations are obtained over a wide variety of hydrologic conditions. Providing that all conditions (i.e. high flow, average flow, base flow, ice-cover) are sampled with equal frequency, a more realistic mean or median value should be obtained and comparison of individual values to "acute" Objectives will have a little more predictive power. Although this alternative may not result in increased costs, it will present some logistic difficulties in terms of field activities. A third possibility

is to combine the data of the present monitoring program with historical data in order to increase the data set and thus provide better coverage over the hydraulic regime and more statistical confidence. It is felt that alternative two and three are both viable and that implementation of both approaches would in the future improve the Water Quality Objective "non-compliance" reports.

INDIVIDUAL OBJECTIVES

Aluminum

Aluminum is insoluble in its elemental form at near-neutral pH. However, many toxic aluminum salts are soluble at pH levels above 7 as well as in acidic waters. The safe level Objective for waters with pH levels above 7 is 0.1 mg/L of total extractable aluminum while the "acute" objective is between 1.0 mg/L to 5.0 mg/L of dissolved aluminum.

The Saint John River generally has a pH above 6 with many measurements above circum-neutral. Therefore the objectives presented above are applicable to the International Saint John River. Tables 3 and 4 present the minimum, maximum, mean and median values of total extractable and total dissolved aluminum, respectively.

The mean concentration of extractable aluminum exceeds the safe Objective (0.1 mg/L) for eight of the eleven international Saint John River sites. However, on April 27, 1982, these sites all had extremely high aluminum concentrations which greatly influenced the mean value. Using the median, only five of the eleven sites exceed the "safe" Objective. With respect to the "acute" Objective only one sample which was collected at Green River on April 27, 1982 (1.2 mg/L) exceeded the Objective.

The interpretation of total or extractable aluminum concentrations are often confounded by association with organic matter. Thus elevated aluminum concentration may not necessarily result in increased toxicity if a large proportion is organically bound. This appears to be the case for the high aluminum concentrations found during April, 1982. High run-off during this period resulted in high suspended solids loads (i.e. surficial sediment) in the non-complying rivers. These suspended solids are probably high in alumino-silicate material which resulted in the elevated aluminum concentrations.

To remove the influence of sediment loading during periods of high run-off, concentrations of dissolved aluminum were also determined. These data indicate close correspondence between the mean and median values and suggest that all sites comply to both the "acute" and "safe" water quality Objectives.

TABLE 3: Extractable aluminum summary statistics and comparison with both "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute L1.0	Safe L0.1
00NB01AD0013	0.037	.037	-	-	1	ID	ID[1]
00NB01AD0001	0.035	.38	.17	.038	3	3/3	N[2]
00NB01AD0016	0.030	.088	.12	.033	4	4/4	N
00NB01AF0021	L.01	1.2	.32	.039	4	3/4	N
00NB01AF0023	0.043	.70	.26	.152	4	4/4	N
00NB01AF0002	L.01	.51	.19	.132	4	4/4	N
01NB01AF0005	0.05	.70	.24	.107	4	4/4	N
00NB01AG0003	0.02	.35	.17	.130	3	3/3	N
01NB01AG0001	0.028	.60	.22	.120	4	4/4	N
00NB01AJ0012	0.015	.13	.08	.075	4	4/4	Y[3]
00NB01AJ0029	L.01	.16	.06	.015	4	4/4	Y

1 - incomplete data for calculation of mean

2 - non-compliance with Objective

3 - compliance with Objective

TABLE 4: Dissolved Aluminum summary statistics and comparison with both "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute L1.0	Safe L0.1
						mg/L	
00NB01AD0013	0.015	0.035	0.03	.021	7	7/7	Y
00NB01AD0001	0.017	0.15	0.05	.045	8	8/8	Y
00NB01AD0016	L.010	0.03	0.02	.015	10	10/10	Y
00NB01AF0021	L.010	0.49	0.09	.010	10	10/10	Y
00NB01AF0023	L.010	0.14	0.05	.041	9	9/9	Y
00NB01AF0002	0.027	0.15	0.05	.042	10	10/10	Y
01NB01AF0005	0.027	0.13	0.05	.037	9	9/9	Y
00NB01AG0003	0.015	0.05	0.03	.036	8	8/8	Y
01NB01AG0101	0.02	0.10	0.04	.045	9	9/9	Y
00NB01AJ0012	0.01	0.05	0.03	.013	9	9/9	Y
00NB01AJ0029	0.01	0.06	0.03	.020	8	8/8	Y

Dissolved Oxygen

Maintenance of dissolved oxygen in freshwater is essential for protection of aquatic biota and prevention of aesthetically displeasing anaerobic decomposition products. A limit for protection of swimmers is set at 2.0 mg/L while the recommended "acute" Objective for the protection of aquatic life is set at 5 mg/L.

In addition to the concentration, percent saturation relative to the wet atmosphere has been shown to be an important consideration for water quality assessment. For example, saturation values above 110% may cause gas bubble disease in some species of fish. The lower "safe" level is given as 80% saturation, a value below which increased risk of adverse effects on the growth and reproduction of aquatic organisms can be expected.

The dissolved oxygen concentrations and saturation complied with the "safe" and "acute" Objectives for all sites on the International Saint John River (Table 5). In spite of this, some low values occurred at St. Leonard and Grand Falls which might imply that there are times during the summer months when there is non-compliance with the "acute" Objective. In fact this is true as AWQM data (WQB, in prep.) at Grand Falls indicated that oxygen concentrations below 5.0 mg/L were found during September of 1983. This may not be restricted to just the summer months, as low oxygen saturations were observed under the ice during February 1983 at both stations. This would imply that there is a heavy

oxygen demand under ice due to high concentrations of allochthonously produced organic matter.

TABLE 5: Dissolved oxygen (concentration; percent saturation) statistics and comparison with both the "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute >5.0	Safe >85%
00NB01AD0013	7.1;82	12.4;106	9.7;95	9.5;96	8	8/8	Y
00NB01AD0001	8.2;85	13.0;114	11.2;100	11.0;100	8	8/8	Y
00NB01AD0016	8.8;95	15.0;107	12.1;102	12.7;101	11	11/11	Y
00NB01AF0021	6.4;70	15.0;117	11.9;85	12.4;102	13	13/13	Y
00NB01AF0023	7.6;86	13.9;110	11.5;91	12.5;97	13	13/13	Y
00NB01AF0002	5.7;67	14.8;101	10.6;91	10.2;94	13	13/13	Y
01NB01AF0005	6.8;60	14.0;100	10.0;89	9.2;93	13	13/13	Y
00NB01AG0003	8.9;89	16.0;127	12.5;108	12.5;108	11	11/11	Y
01NB01AG0001	7.3;81	14.2;103	11.1;97	11.3;99	12	11/11	Y
00NB01AJ0012	6.8;83	15.6;133	12.2;104	12.3;103	11	11/11	Y
00NB01AJ0029	7.8;60	14.9;114	11.4;97	11.3;102	13	13/13	Y

pH

The pH of the Saint John River generally lies within the range 6.2 to 8.0. The range of pH tolerance for fish species is from 5.0 to 9.5 with much more critical levels being tolerated over short time periods. In addition to the direct effects on aquatic growth and reproduction, pH is important in mediating solubilities of dissolved materials such as gases, salts and metals. The recommended safe pH Objective is the range of 6.0 to 9.0 while the acute limits are values outside the range 4.2 to 9.8.

On all occasions, pH values at the eleven stations complied with both the "acute" and "safe" Objectives (Table 6). The minimum pH values were similar at all sites ranging from 6.3 to 6.6. The four transboundary streams (Limestone, Aroostook, Big Presquile and Meduxnekeag) had highly variable pH values relative to the other sites. Large diurnal fluctuations in both carbon dioxide and pH are characteristic of highly productive streams such as these. This high productivity may also explain the high supersatured oxygen conditions observed for the Limestone, Big Presquile and Meduxnekeag.

TABLE 6: pH statistics and comparisons with both the "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute >4.2<9.8	Safe >6.0<9.0
00NB01AD0013	6.8	7.7	6.9	7.1	9	9/9	Y
00NB01AD0001	6.5	8.4	7.1	7.5	9	9/9	Y
00NB01AD0016	6.3	7.9	6.9	7.4	13	9/9	Y
00NB01AF0021	6.3	7.9	6.9	7.3	13	9/9	Y
00NB01AF0023	6.3	8.1	7.0	7.3	13	13/13	Y
00NB01AF0002	6.2	7.7	6.9	7.3	13	13/13	Y
01NB01AF0005	6.3	7.5	6.9	7.3	13	13/13	Y
00NB01AG0003	6.6	9.0	7.4	7.9	11	11/11	Y
01NB01AG0001	6.3	8.6	6.9	7.4	12	12/12	Y
00NB01AJ0012	6.5	8.5	7.2	7.8	11	11/11	Y
00NB01AJ0029	6.3	8.4	7.1	7.5	13	13/13	Y

Phosphate

Eutrophication of freshwater systems is a response to high nutrient loads, with phosphorus generally being the nutrient of major concern. The main difficulty associated with eutrophication is the effect on the aesthetic quality of the water due to increased production of noxious algae. In addition elevated primary production may result in oxygen depletion in the tropholytic region as well as problems associated with shifts in species dominance, and the production of algal toxins and antibiotics.

In general, a phosphate Objective should be set such that eutrophication is prevented. However due to the complexity of interrelationships that occur with other nutrients, major ions and biological and physical characteristics of the aquatic system, a definite phosphate limit cannot be set. In order to prevent the establishment of nuisance conditions, it has been recommended that phosphorus not exceed 0.1 mgP/L in flowing streams, 0.05 mgP/L in streams entering an impoundment and 0.025 mgP/L in an impoundment. The State of Maine experience suggests that values exceeding 0.015 mg/L are indicative of potential problems and thus if phosphorus concentrations on a seasonal basis exceed this level a survey to determine the trophic status of the water should be undertaken.

A summary of the total dissolved phosphorus concentrations for the international Saint John River stations are presented in Table 7. There

are some occasions on which total rather than total dissolved phosphorus concentrations were determined and these have been included in the mean value calculations. In situations where this is expected to significantly affect the mean value the median will be used. Of the eleven sites sampled, seven had mean values which did not comply with the "safe" Objectives of 0.015 mg/L. The three Saint John River sites, as well as Green River, had mean values which were significantly affected by a high total phosphorus value found during April of 1982. Using the median value for these sites indicates that they all comply with the "safe" Objective. The high total phosphorus values encountered in April 1982 are a result of a period of high flow and high sediment load. However, much of this total phosphorus may be associated with organic matter and clays and thus would not be available for primary production. This would indicate that the use of total dissolved or soluble reactive phosphorus would be much more appropriate as an eutrophication indicator than total phosphorus, particularly in those sites which have high concentrations of organic matter or high suspended solid loads. The three sites which are of greatest concern with respect to eutrophication are the transboundary streams, the Limestone, Aroostook and Big Presquile. These streams have both mean and median values above the "safe" Water Quality Objective and thus can be considered to be susceptible to algal blooms. The Meduxnekeag which has historically had an eutrophication problem, met the "safe" Objective, signifying that the nutrient loading conditions in this river have improved significantly in recent years. Before proceeding further it must be pointed out that blind use of total phosphorus concentrations

as eutrophic indicators may be somewhat misleading. During the winter months, particularly under ice cover, light rather than nutrient concentration is generally limiting. Thus a nutrient concentration which exceeds the "acute" guideline in the winter may have little or no effect on primary productivity. For this reason many trophic category schemes are based on ice-free season (Vollenweider & Kerekes, 1980) rather than annual means.

In addition, the assumption that the system is phosphorus limited cannot be made without the support of water quality data. Although phosphorus is generally the limiting factor in freshwater systems, other nutrients such as nitrogen and to a lesser extent carbon and silica may also be of importance. The probability of nitrogen limitation is low if the N:P ratio exceeds approximately 10:1 (Vollenweider & Kerekes, 1980). For the international Saint John River stations this is indeed the case as the N:P ratio is generally above 20. and thus the assumption of phosphorus limitation is probably acceptable.

Using the "acute" Objectives it is apparent that with the exception of the transboundary streams, the only non-compliance values result for total phosphorus concentrations occurs during a period of high sediment loading. However, using the impoundment Objective of 0.025 mg/L the transboundary streams, excluding the Meduxnekeag had several non-compliance values. Although some of these values occur during the winter, others, particularly at Big Presquile, are observed during the spring and summer months. Thus these data would suggest that the

Limestone, Aroostook and Big Presquile are presently receiving elevated nutrient loads resulting in subsequent eutrophication. The fact that these streams have highly variable pH and dissolved oxygen concentrations would support the contention that they are highly productive. The Meduxnekeag oxygen concentrations and pH values also indicate high productivity, even though this river complies with the phosphorus "acute" and "safe" Objectives.

TABLE 7: Total phosphorus statistics and comparison with both the "acute" and "safe" Water Quality Objectives

Station	Min	Max	Mean	Median	N	Acute L.1 mg/L	Safe L.015
00NB01AD0013	.003	0.011	.006	.005	8	8/8	Y
00NB01AD0001	.004	0.090	.018+	.006	9	9/9	N
00NB01AD0016	.005	0.060	.014	.009	11	11/11	Y
00NB01AF0021	.001	0.13	.017+	.005	10	9/10	N
00NB01AF0023	.003	0.011	.007	.007	10	10/10	Y
00NB01AF0002	.004	0.18	.026+	.008	11	10/11	N
01NB01AF0005*	.003	0.17	.024+	.007	10	9/10	N
00NB01AG0003*	.002	0.050	.025	.015	9	8/9	N
01NB01AG0001*	.014	0.072	.032	.020	9	5/9	N
00NB01AJ0012*	.004	0.072	.022	.017	11	8/11	N
00NB01AJ0029	.005	0.028	.011	.010	9	9/9	Y

* As a consequence of controlled or naturally low discharge, the "acute" impoundment objective of 0.025 mg/L has been used for these sites.

\+ A single total phosphorus value has considerable influence on the mean.

Suspended Solids

Suspended solids have no adverse effect on swimming but may interfere with the biota due to habitat disturbance caused by siltation. The "safe" level Objective suggests that average suspended solid concentrations should not exceed 25 mg/L. On an individual sample basis concentrations of suspended solids greater than 100 mg/L indicate poor land use practices and possible detrimental effects on the aquatic biota.

Suspended solids did not appear to be of any major concern for the eleven international Saint John River sites (Table 8). The Green River had one value which did not comply with the "acute" Objective during a very high discharge period in April of 1982. The mean suspended solid value for the Grand River slightly exceeded the 25 mg/L "safe" Objective. However, as this mean value was weighted by a couple of high individual values, the use of the median value is warranted. This median dose complies with the "safe" Objective for suspended solids.

TABLE 8: Suspended Solids statistics and comparison with both the "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute <100	Safe <25
00NB01AD0013	L10	L10	L10	L10	6	6/6	Y
00NB01AD0001	L10	48	15	L10	7	7/7	Y
00NB01AD0016	L10	36	15	L10	9	9/9	Y
00NB01AF0021	L10	157	25	L10	9	8/9	Y
00NB01AF0023	L10	89	27	10	9	9/9	N
00NB01AF0002	L10	59	20	L10	9	9/9	Y
01NB01AF0005	L10	83	20	L10	9	9/9	Y
00NB01AG0003	L10	29	15	L10	7	7/7	Y
01NB01AG0001	L10	60	20	L10	9	9/9	Y
00NB01AJ0012	L10	60	17	L10	8	8/8	Y
00NB01AJ0029	L10	27	12	L10	8	8/8	Y

Temperature

Establishment of a water temperature objective is extremely difficult as aquatic organisms have a wide range of optimum temperatures. Water temperatures which are too high or low or change too rapidly can have detrimental effects on the aquatic environment. In addition water temperature can have indirect effects by changing chemical reactions and solubility of gases and salts, etc. The suggested desirable temperature range is 15°C to 20°C during the summer and 0°C to 8°C in the winter. Also the acute limit suggests that anthropogenic activities should not increase water temperature by more than 0.5°C when the ambient temperature is greater than 25°C throughout the water column.

The maximum water temperatures at the eleven sites ranged from 19.5°C in the Green River to 26.0°C at the Aroostook River Headpond. The Aroostook River is the only site which did not comply with the 25°C critical level. However, as the Aroostook Headpond is approximately 8 m deep, the high surface water temperature would probably have little detrimental effect on aquatic organisms due to the availability of cooler deep water refuge.

TABLE 9: Maximum water temperature and comparison with the suggested "critical" level

Station	Max	# of Samples	Critical Level >25°C
00NB01AD0013	21.5	8	Y
00NB01AD0001	24.0	8	Y
00NB01AD0016	21.5	12	Y
00NB01AF0021	19.5	13	Y
00NB01AF0023	20.0	13	Y
00NB01AF0002	22.2	13	Y
01NB01AF0105	20.6	12	Y
00NB01AG0003	22.0	11	Y
01NB01AG0001	26.0	12	N
00NB01AJ0012	24.2	11	Y
00NB01AJ0029	24.0	13	Y

Zinc

Zinc has been shown to be toxic to salmonids at levels ranging from 0.15 to 1.0 mg/L depending on season and developmental stages (Zitko and Carson, 1976). Adverse effects such as diarrhea have been reported in man, only at extremely high levels, (approx. 600 mg/L). The safe level for zinc has been set at 0.03 mg/L and the acute limit of 0.08 mg/L has been recommended. All sites on the International Saint John River exhibited low levels of extractable zinc with all mean values complying to the "safe" Objective (Table 10). On one occasion an individual value for the Green River exceeded the "acute" Objective.

TABLE 10: Zinc statistics and comparison with both the "acute" and "safe" Objectives

Station	Min	Max	Mean	Median	N	Acute <0.08	Safe <0.03
00NB01AD0013	L.002	0.02	.010	.01	5	5/5	Y
00NB01AD0001	0.004	0.03	.010	.007	4	4/4	Y
00NB01AD0016	L.002	0.03	.010	.01	7	7/7	Y
00NB01AF0021	L.002	0.10	.027	.01	6	5/6	Y
00NB01AF0023	0.003	0.03	.013	.01	7	7/7	Y
00NB01AF0002	0.005	0.04	.013	.01	7	7/7	Y
01NB01AF0005	0.004	0.04	.012	.01	7	7/7	Y
00NB01AG0003	L.002	0.03	.011	.01	7	7/7	Y
01NB01AG0001	L.002	0.03	.011	.01	6	6/6	Y
00NB01AJ0012	L.002	0.03	.012	.01	7	7/7	Y
00NB01AJ0029	L.002	0.03	.012	.01	6	6/6	Y

SUMMARY

Comparison of the Saint John River 1982/1983 water quality data with Water Quality Objectives indicated that there was overall compliance for pH, dissolved oxygen, suspended solids, water temperature and zinc. Although dissolved oxygen complied at all stations, AWQM data from Grand Falls indicated a non-compliance situation during early September of 1982.

Mean extractable aluminum concentrations did not comply with the "safe" Objective at eight out of the eleven stations. However, this was the result of high loading of aluminum rich sediment and thus probably does not represent potential toxicity effects. If dissolved aluminum concentrations are considered all stations complied with both the "safe" and "acute" Objectives.

A similar situation exists for phosphorus concentration with several sites exceeding the "safe" guideline when total phosphorus concentrations are considered. Reducing the weight of high total phosphorus values during periods of high sediment loads by considering the median rather than the mean, removes several of the non-compliance stations. However three of the transboundary streams still do not comply with the "safe" or occasionally with the "acute" Objectives. This coupled with the fact that some of the non-complying individual values occur during the highly productive summer period suggests that these three streams are presently being eutrophied, and that more

intensive sampling should be initiated in order to characterize trophic status.

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